Physicsaholics

DPP –5 & 6 (EMI)

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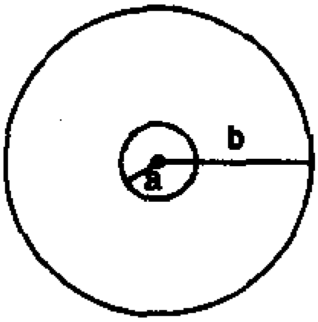
Written Solution on Website:- https://physicsaholics.com/note/notesDetalis/65

Q 1. Mutual inductance of two coils is M. First coil has constant current i and second has no current. If current in first coil dies out in very short time, magnitude of charge which will move in second coil is a (resistance of each coil is R)

(a) $\frac{Mi}{R}$
(b) $\frac{2Mi}{R}$
(c) $\frac{Mi}{2R}$
(d) None of these

Q 2. Two concentric and coplanar circular coils have radii a and b(>>a) as shown in figure. Resistance of the inner coil is R. Current in the outer coil is increased from 0 to i, then the total charge circulating the inner coil is:

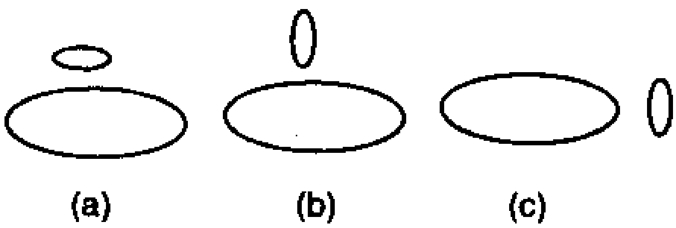


(a) $\frac{\mu_0 ia^2}{2Rb}$ (b) $\frac{\mu_0 iab}{2R}$ (c) $\frac{\mu_0 i\pi b^2}{2Ra}$ (d) $\frac{\mu_0 ib}{2\pi R}$

Q 3. A small square loop of wire of side l is placed inside a large square loop of wire of side L(L> > l). The loops are coplanar and their centres coincide. The mutual inductance of the system is proportional to:

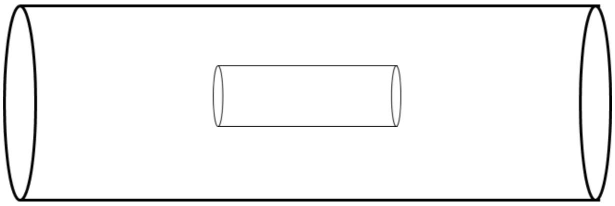
(a) l/L (b) l^2/L (c) L/l (d) L^2/l

Q 4. Two circular coils can be arranged in any of the three situations shown in the figure. Their mutual inductance will be:



(a) maximum In situation (a) (b) maximum in situation (b)
(c) maximum in situation (c) (d) the same in all situations

Q 5. A short solenoid of length l_1, cross sectional area A_1, and no of turns per unit length n_1 is placed at centre of long solenoid of length l_2, cross sectional area A_2, and no of turns per unit length n_2. Mutual inductance of solenoid will be



(a) $\mu_0 A_1\, l_1\, n_1 n_2$
(b) $\mu_0 A_2\, l_2\, n_1 n_2$
(c) $\mu_0 A_1\, l_2\, n_1 n_2$
(d) $\mu_0 A_2\, l_1\, n_1 n_2$

Q 6. Two coils, 1 & 2, have a mutual inductance = M and resistances R each. A current flows in coil 1, which varies with time as; $I_1 = kt^2$, where k is a constant and 't' is time. Find the total charge that has flown through coil 2, between t = 0 and t = T.
(a) $2kMT^2/R$ (b) $kMT^2/2R$
(c) $4kMT^2/R$ (d) kMT^2/R

Q 7. Two coaxial solenoids are made by winding thin insulated wire over a pipe of cross-sectional area A = 10 cm^2 and length = 20 cm. If one of the solenoids has 300 turns and the other 400 turns, their mutual inductance is ($\mu_0 = 4\pi \times 10^{-7} TmA^{-1}$)
(a) $2.4\pi \times 10^{-5}$ H
(b) $4.8\,\pi \times 10^{-4}$H
(c) $4.8\pi\times10^{-5}$H
(d) $2.4\,\pi \times10^{-4}$H

Q 8. If we increase no of turns in a coil to n times, self inductance will increase to
(a) n times
(b) n^2 times
(c) n^3 times
(d) n^4 times

Q 9. Two identical solenoids are placed coaxially at large separation r from each other. Each solenoid has no of turns per unit length n and length l and cross sectional area A. mutual inductance of solenoids is
(a) $\frac{\mu_0 n^2 l^2 A^2}{2\pi r^3}$ (b) $\frac{\mu_0 n^2 l^4 A^2}{2\pi r^2}$
(c) $\frac{\mu_0 n^2 l^2 A^2}{4\pi r^3}$ (d) $\frac{\mu_0 n^2 l^2 A^2}{2\pi r^2}$

Q 10. Two coils are at fixed locations. When coil 1 has no current and the current in coil 2 increases at the rate 15.0 A/s the e.m.f. in coil 1 in 25.0 mV, when coil 2 has no current and coil 1 has a current of 3.6 A, flux linkage in coil 2 is-
(a) 16 mWb
(b) 10 mWb

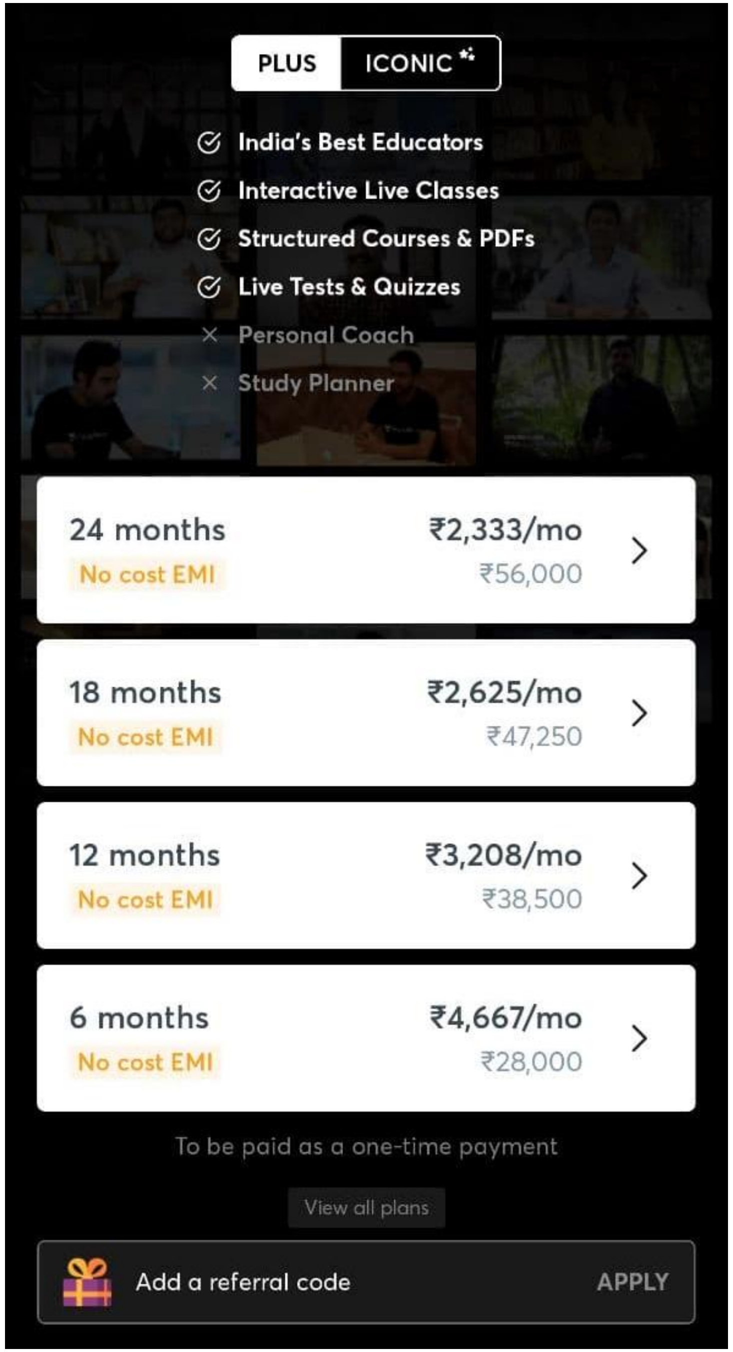
(c) 4 mWb
(d) 6 mWb

Q 11. A long straight wire is placed along the axis of a circular ring of radius R. The mutual inductance of this system is-
(a) $\frac{\mu_0 R}{2}$
(b) $\frac{\pi\mu_0 R}{2}$
(c) $\frac{\mu_0 R}{4}$
(d) 0

Q 12. A solenoid of self inductance L is devided in to two equal parts to make two solenoids . Self inductance of one part
(a) is equal to L/2
(b) is less than L/2
(c) is greater than L/2
(d) None of these

Answer Key

Q.1 a	Q.2 a	Q.3 b	Q.4 a	Q.5 a
Q.6 d	Q.7 d	Q.8 b	Q.9 a	Q.10 d
Q.11 d	Q.12 b			



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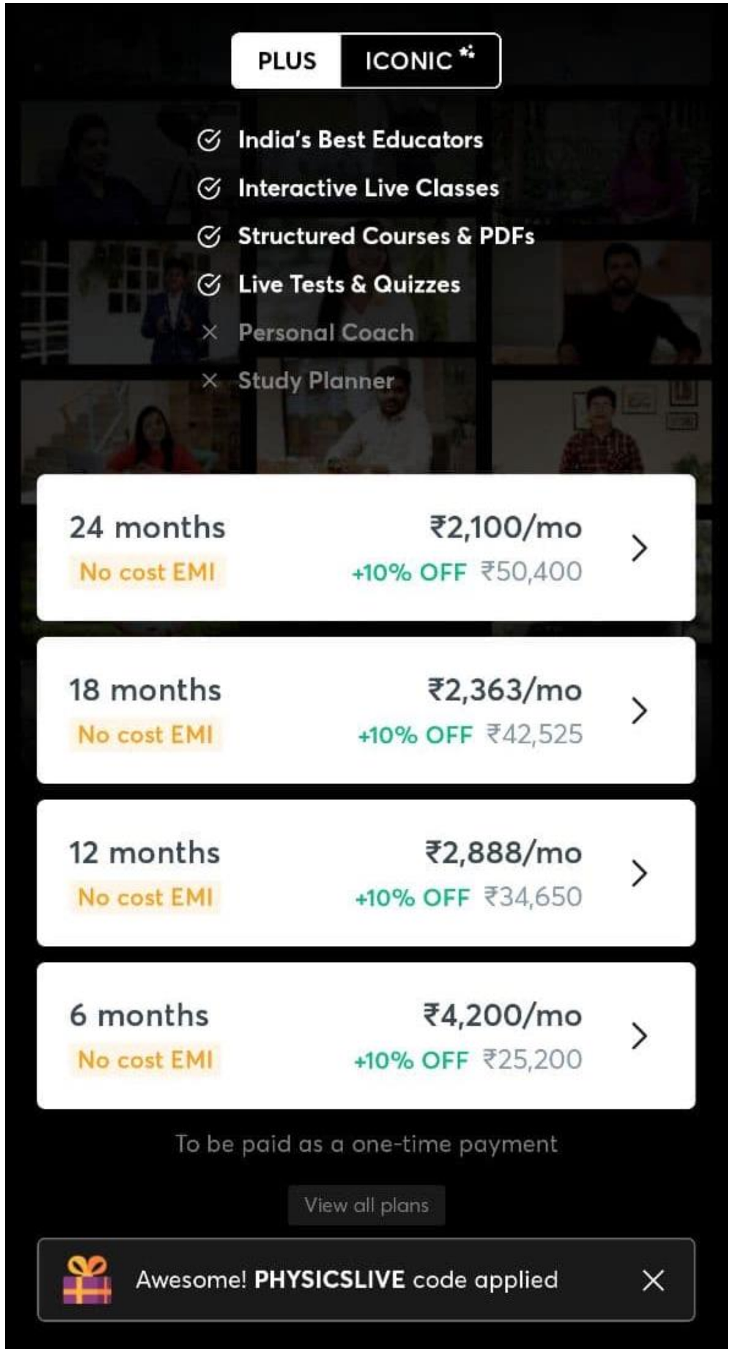

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Written Solution

DPP- 5 & 6 EMI- Mutual Induction, Self Inductance of Solenoid, relation between mutual induction and self induction

By Physicsaholics Team

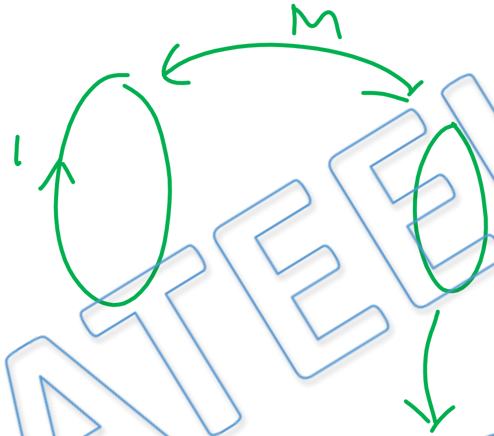
Q.1) Mutual inductance of two coils is M. First coil has constant current i and second has no current. If current in first coil dies out in very short time, magnitude of charge which will move in second coil is a (resistance of each coil is R)

(a) $\frac{Mi}{R}$

(b) $\frac{2Mi}{R}$

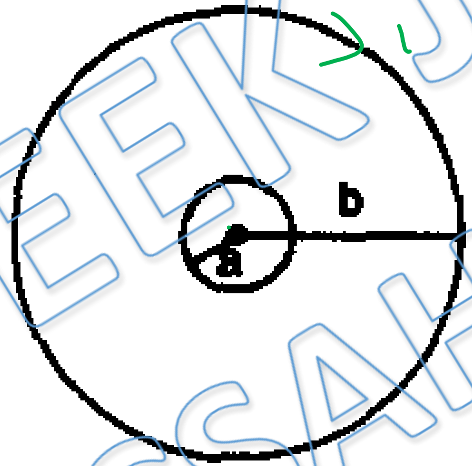
(c) $\frac{Mi}{2R}$

(d) None of these



$$q = \left| -\frac{\Delta\phi}{R} \right| = \frac{Mi}{R}$$

Q.2) Two concentric and coplanar circular coils have radii a and b(>>a) as shown in figure. Resistance of the inner coil is R. Current in the outer coil is increased from 0 to i, then the total charge circulating the inner coil is:



$B = \frac{\mu_0 i}{2\pi b}$

$\phi = \frac{\mu_0 i \pi a^2}{2\pi b} = \frac{\mu_0 i a^2}{2b}$

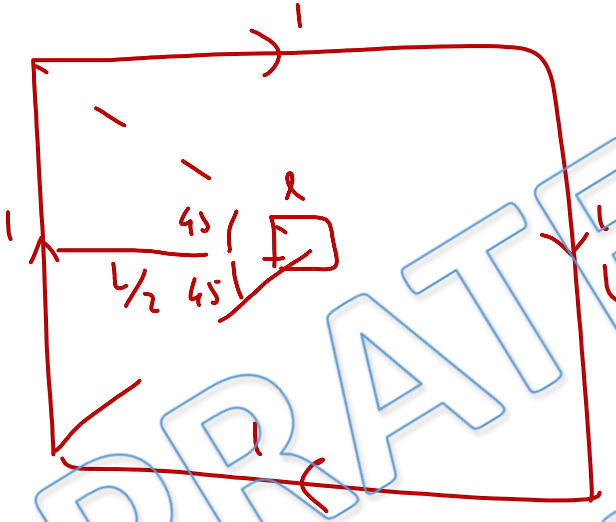
$M = \frac{\mu_0 a^2}{2b}$

$\Delta\phi = Mi = \frac{\mu_0 a^2 i}{2b}$

$q = \left| -\frac{\Delta\phi}{R} \right| = \frac{\mu_0 a^2 i}{2bR}$

(a) $\frac{\mu_0 i a^2}{2Rb}$ ✓ (b) $\frac{\mu_0 i a b}{2R}$ (c) $\frac{\mu_0 i \pi b^2}{2Ra}$ (d) $\frac{\mu_0 i b}{2\pi R}$

Q.3) A small square loop of wire of side l is placed inside a large square loop of wire of side L(L> > l). The loops are coplanar and their centres coincide. The mutual inductance of the system is proportional to:



field at Centre

$$= 4\left[\frac{\mu_0 I}{4\pi \frac{L}{2}}(\sin 45 + \sin 45)\right]$$

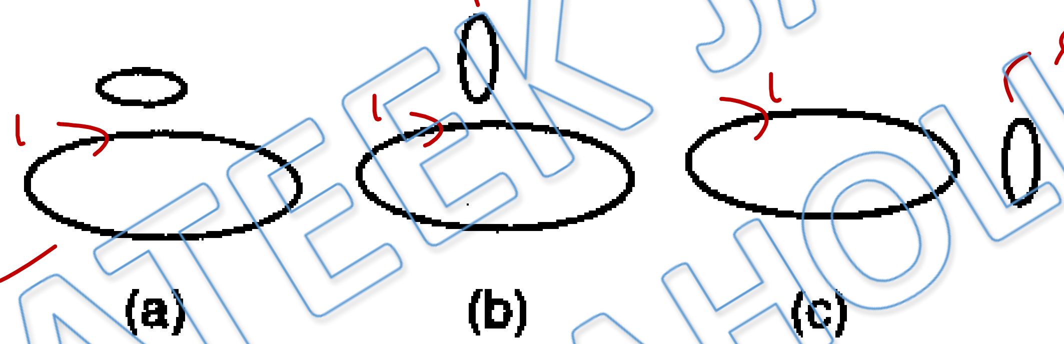
$$= \frac{2\mu_0 I}{\pi L} \times \sqrt{2}$$

(a) l/L (b) l^2/L (c) L/l (d) L^2/l

$$\phi = \frac{2\mu_0 I \sqrt{2}\, l^2}{\pi L}$$

Q.4) Two circular coils can be arranged in any of the three situations shown in the figure. Their mutual inductance will be:

$M = \frac{\phi}{I}$



(a) maximum In situation (a)

(b) maximum in situation (b)

(c) maximum in situation (c)

(d) the same in all situations

Q.5)A short solenoid of length l_1 , cross sectional area A_1, and no of turns per unit length n_1 is placed at centre of long solenoid of length l_2 , cross sectional area A_2, and no of turns per unit length n_2 . Mutual inductance of solenoid will be

(a) $\mu_0 A_1\, l_1\, n_1 n_2$ ✓

(b) $\mu_0 A_2\, l_2\, n_1 n_2$

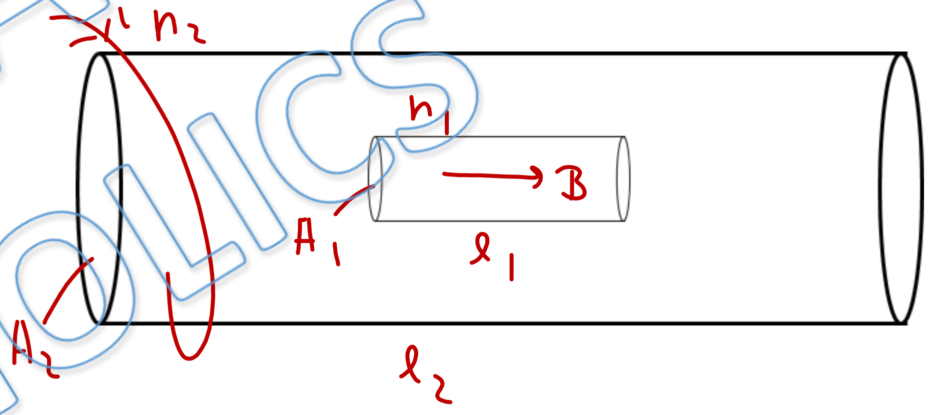
(c) $\mu_0 A_1\, l_2\, n_1 n_2$

(d) $\mu_0 A_2\, l_1\, n_1 n_2$

$B = \mu_0 n_2 i$

$\phi = (\mu_0 n_2 i A_1)(n_1 l_1)$

$M = \mu_0 n_1 n_2 A_1 l_1$



Q.6) Two coils, 1 & 2, have a mutual inductance = M and resistances R each. A current flows in coil 1, which varies with time as; $I_1 = kt^2$, where k is a constant and 't' is time. Find the total charge that has flown through coil 2, between t = 0 and t = T.

(a) $2kMT^2/R$

(b) $kMT^2/2R$

(c) $4kMT^2/R$

(d) kMT^2/R

$\phi = Mkt^2$

at t = 0

$\phi = 0$

at t = T

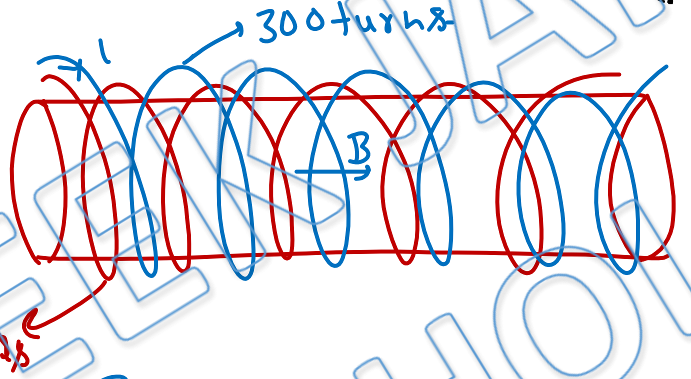
$\phi = MkT^2$

$\Delta\phi = Mk\Delta T^2$

$q = \left|-\frac{\Delta\phi}{R}\right|$

$= \frac{MkT^2}{R}$

Q.7) Two coaxial solenoids are made by winding thin insulated wire over a pipe of cross-sectional area A = 10 cm^2 and length = 20 cm. If one of the solenoids has 300 turns and the other 400 turns, their mutual inductance is ($\mu_0 = 4\pi \times 10^{-7} TmA^{-1}$)



(a) $2.4\pi \times 10^{-5}$ H

(b) $4.8\pi \times 10^{-4}$ H

(c) $4.8\pi \times 10^{-5}$ H

(d) $2.4\pi \times 10^{-4}$ H

$B = \mu_0 \frac{300}{(1/5)} I = 1500 \mu_0 I$

$\phi = BAN = 1500 \mu_0 I \times (10 \times 10^{-4}) 400$

$\phi = 600 \mu_0 I$

$M = 600 \times \mu_0 = 600 \times 4\pi \times 10^{-7}$

$= 24\pi \times 10^{-5}$

$= 2.4\pi \times 10^{-4}$

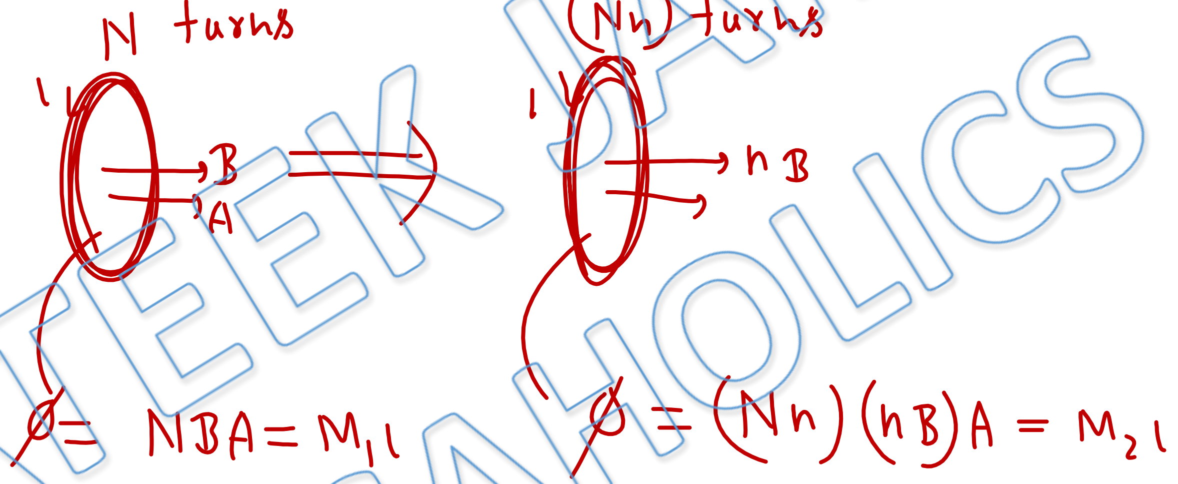
Q.8) If we increase no of turns in a coil to n times, self inductance will increase to

(a) n times

(b) n^2 times

(a) n^3 times

(b) n^4 times



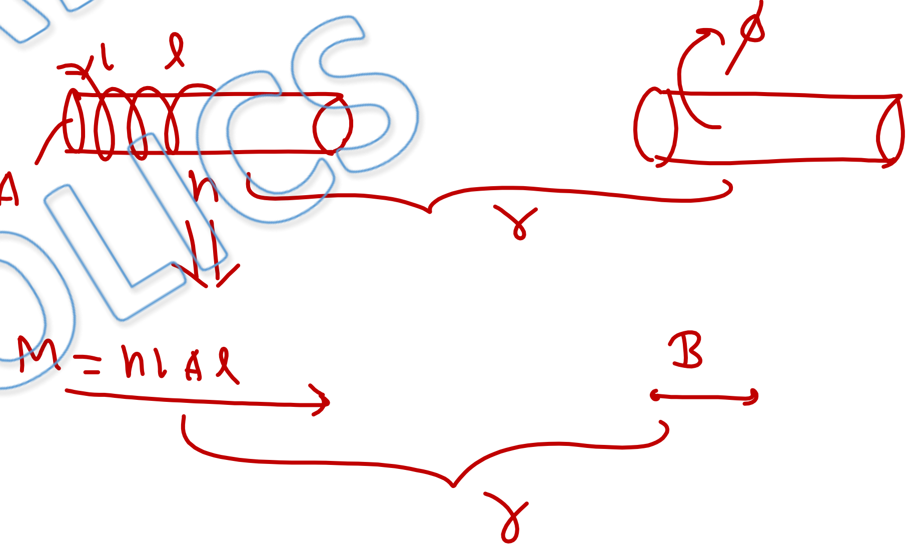
Q.9) Two identical solenoids are placed coaxially at large separation r from each other. Each solenoid has no of turns per unit length n and length l and cross sectional area A. mutual inductance of solenoids is

(a) $\frac{\mu_0 n^2 l^2 A^2}{2\pi r^3}$

(b) $\frac{\mu_0 n^2 l^4 A^2}{2\pi r^2}$

(c) $\frac{\mu_0 n^2 l^2 A^2}{4\pi r^3}$

(d) $\frac{\mu_0 n^2 l^2 A^2}{2\pi r^2}$



$M = nIAl$

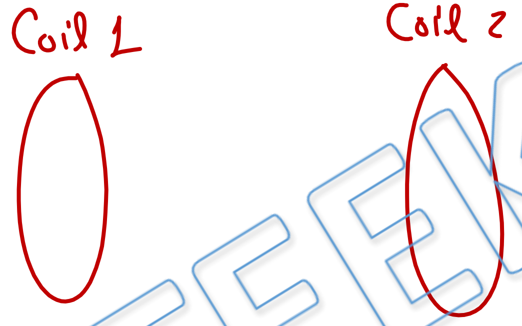
$\phi = BAnl = \frac{\mu_0 n^2 A^2 l^2}{2\pi r^3} I$

$M = \frac{\mu_0 n^2 A^2 l^2}{2\pi r^3}$

$B = \left(\frac{\mu_0}{4\pi}\right)\frac{2M}{r^3}$

$B = \frac{\mu_0 n I A l}{2\pi r^3}$

Q.10) Two coils are at fixed locations. When coil 1 has no current and the current in coil 2 increases at the rate 15.0 A/s the e.m.f. in coil 1 in 25.0 mV, when coil 2 has no current and coil 1 has a current of 3.6 A, flux linkage in coil 2 is-



(a) 16 mWb

(b) 10 mWb

(c) 4 mWb

(d) 6 mWb

$\mathcal{E} = M \frac{di}{dt}$

$25m = M \, 15$

$M = \frac{25}{15} m = \frac{5}{3} m$

$\phi = Mi$

$= \frac{5}{3} m \times 3.6$

$= 6 \, mWb$

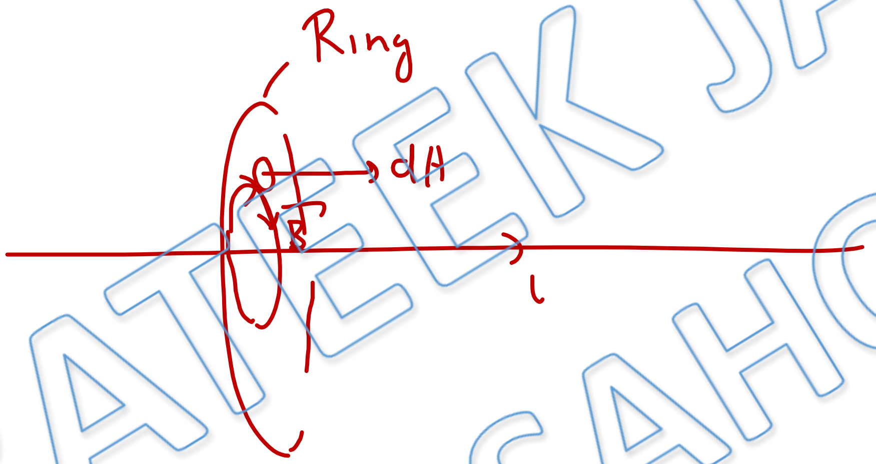
Q.11) A long straight wire is placed along the axis of a circular ring of radius R. The mutual inductance of this system is-

(a) $\frac{\mu_0 R}{2}$

(b) $\frac{\pi \mu_0 R}{2}$

(c) $\frac{\mu_0 R}{4}$

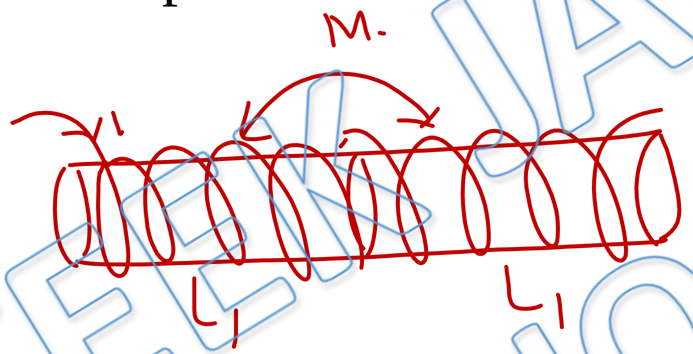
(d) 0



$\phi = 0$

$M = 0$

Q.12) A solenoid of self inductance L is devided in to two equal parts to make two solenoids . Self inductance of one part



(a) is equal to L/2

(b) is less than L/2

(c) is greater than L/2

(d) None of these

$\phi = L_1 i + M i + L_1 i + M i$

$\phi = (2L_1 + 2M) i$

$L = 2L_1 + 2M$

$L_1 = \frac{L}{2} - M$

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